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GEOPHYSICAL VARIABLES AND BEHAVIOR: LXXVI. SEASONAL HYDROLOGICAL LOAD AND REGIONAL LUMINOUS PHENOMENA (UFO REPORTS) WITHIN RIVER SYSTEMS, THE MISSISSIPPI VALLEY TEST[1]

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Summary.—We hypothesized that an equilibrium in seasonal variations between water load and both seismicity and reports of odd, spherical, luminous phenomena within the river basin should result in systematic but phase-lagged relationships between these variables. Within 320 km of the confluence of the Mississippi System, the monthly variation of a specific and major class of UFO reports (which appear to represent luminous phenomena that are generated by tectonic strain) peaked 3 to 4 months ($r = 0.87$) after the river crested. The phase lag between these luminous phenomena and seismic activity within the same region was about 6 months. The results support the model that river load-induced strain and fluid percolation into and diffusion within the earth's crust promote the production of natural luminous phenomena.

The tectonic strain hypothesis (Derr & Persinger, 1986; Persinger, 1990) predicts that any environmental factor that induces changes in crustal (tectonic) stress should be associated with a specific subset of reports of unidentified flying objects (UFOs) because they are contemporary labels for natural luminous phenomena (LP). Brief periods of fluid injection should be associated with transient increases in luminous phenomena (Derr & Persinger, 1990; Persinger & Derr, 1993). There have been frequent associations between flooding or changes in the water levels of reservoirs and increases in local seismicity. For example, an anomalous earthquake near Amarillo, Texas during July, 1966 occurred about 1.5 years after water storage began in a newly created lake (Meredith) which had achieved only about one-quarter of its capacity (Shurbet, 1969).

However, persistent periodic changes in natural "fluid injection" in conjunction with water loads within larger river basins (Costain, Bollinger, & Speer, 1987) should display stronger and more conspicuous relationships between seismicity, fluid volume measurements, and luminous phenomena. We first noted a conspicuous association between monthly fluid load (level) in the Red River System and the monthly occurrence of the luminous phenomena around Carman, Manitoba (Persinger & Derr, 1985) that preceded an earthquake of unusual magnitude within the region. Other temporal associa-

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tions between hydrological anomalies and luminous phenomena could include the Zeitoun (Cairo), Egypt phenomena (alleged luminous apparitions of the Virgin Mary; Derr & Persinger, 1989) that began after the diversion of the annual flooding of the Nile River by the Aswan Dam and the Tashkent, Uzbekistan earthquake lights and earthquake of 1966 that followed the diversion of water from the Aral Sea during the earlier portion of that decade.

As a first test of this hypothesis, we evaluated the temporal associations between luminous phenomena, earthquakes, and water level of Roosevelt Lake (Grand Coulee Dam) in Washington state. The years 1954 through 1963 were selected because we had all three types of data for this interval. The mean numbers of specific luminous phenomena (SLP) per month [which constitute Types III through VI of the CUFOS "strangeness" spectrum (see Derr & Persinger, 1990)] within 100 km of the dam ($M = 2.2$, $SD = 1.5$, respectively), mean numbers of earthquakes per month within 100 km (1.5, $SD = 1.6$), and mean water level (in feet) per month (1274, $SD = 13.7$) were obtained from the Center for UFO Studies (CUFOS), the U.S. Geological Survey, and the U.S. National Weather Service, respectively. To discern the effect of temporal changes in fluid load, the depths of the lake for each month were subtracted from the value of the previous month [95% of the months involved values between -22 and $+22$ ft. or about 2% of the total depth]; lags were calculated to discern temporal delays of up to 6 months.

Pearson correlations (Spearman *rho* values were essentially the same coefficients) were completed between the average monthly measures for each of the three variables. There were positive associations between specific luminous phenomena and water level (0.43), water level and numbers of quakes within 100 km (0.51) but not 200 km (-0.19) of the dam, and specific luminous phenomena and quakes (0.55). Because the number of cases was equal to the number of months/year ($n = 12$), these correlations were either marginally significant ($p < .05$) or only approached statistical significance ($p < .10$). Lag correlations of up to 6 months (with number of cases still = 12) did not approach this level of significance.

Lag correlations (time series) between the change in monthly depth (and hence volume) and the numbers of specific luminous phenomena within serial 50-km increments from the Grand Coulee Dam (up to 200 km) over the 120-mo. period showed weak but statistically significant positive correlations: (1) specific luminous phenomena within 0 and 50 km and change in volume during the same month ($rho = 0.21$, $p < .01$), (2) specific luminous phenomena within 50 km and 100 km and change in volume during the previous month ($rho = 0.16$, $p < .05$), and (3) specific luminous phenomena within 100 and 150 km and change in lake volume 6 months earlier ($rho = 0.18$, $p < .05$). Except for a decrease in specific luminous phenomena between 150 and 200 km if net volumes had dropped 3 and 4 months previously ($rho =$

– .22, – .16), other lags with any of the other radial distances were not statistically significant. Partial correlation for temporal series (years) did not change the major effect: the partial r between changes in water level and specific luminous phenomena within 50 km for the same month was 0.30 (df = 118, p = .001).

If simple mass is one of the critical variables that drive crustal load, we predicted that the association among fluid volume, seismicity, and specific luminous phenomena should be very evident within a very large river basin. McGinnis (1963) noted a significant relationship between monthly water load within the alluvial valley within 200 miles (320 km) of New Madrid, Missouri and monthly variations in seismicity (peak in January; trough in June). If both luminous phenomena and seismicity emerge from strain associated with variable hydrological loads, then a systematic relationship between these variables should be evident. By utilizing monthly values rather than serial yearly measures of luminous phenomena, we reasoned that an average monthly signal would emerge that would be minimally affected (as are yearly variations) by the irregular episodes of luminous phenomena and seismicity.

We selected the 19-year increment between 1945 and 1965 for analyses. This period contains well-documented cases of luminous phenomena from the CUFOS file; after the year 1965 there appears to have been a change in the criterion for admission into the database. Because we were investigating the monthly variations in luminous phenomena during this 19-yr. period within this region, the problems of sample size were less important. Consequently, we decided to test formally the hypothesis that specific luminous phenomena in particular should be most associated with numbers of quakes within the region and with the changes in river volume.

From the appropriate data bases, we calculated: (1) the numbers of the total numbers of specific luminous phenomena per month within 320 km (200 mi) of New Madrid, Missouri, (2) the average monthly river stage in feet (Hickman, Kentucky), and (3) the numbers of seismic events (Nuttli record; Barstow, Brill, Nuttli, & Pomeroy, 1981) within 320 km during this period. In addition, the numbers of times a month contained at least one report of specific luminous phenomena or general luminous phenomena during the 19-yr. period (hence the monthly score could range between 0 and 19) was also obtained. These conservative measures of luminous phenomena were assigned to minimize distortions from intense luminous phenomena episodes ("flaps") We also calculated a measure of luminous phenomena density which was defined as numbers of general luminous phenomena that occurred at distances of more than 1° latitude or longitude during the same week or the numbers of general luminous phenomena separated by at least one week within the same coordinates. This measure was calculated to accommodate the magnitudes of various episodes of luminous phenomena.

As shown in Fig. 1a, the first obvious visual pattern is the uneven monthly distribution of river level, quakes, and luminous phenomena. All

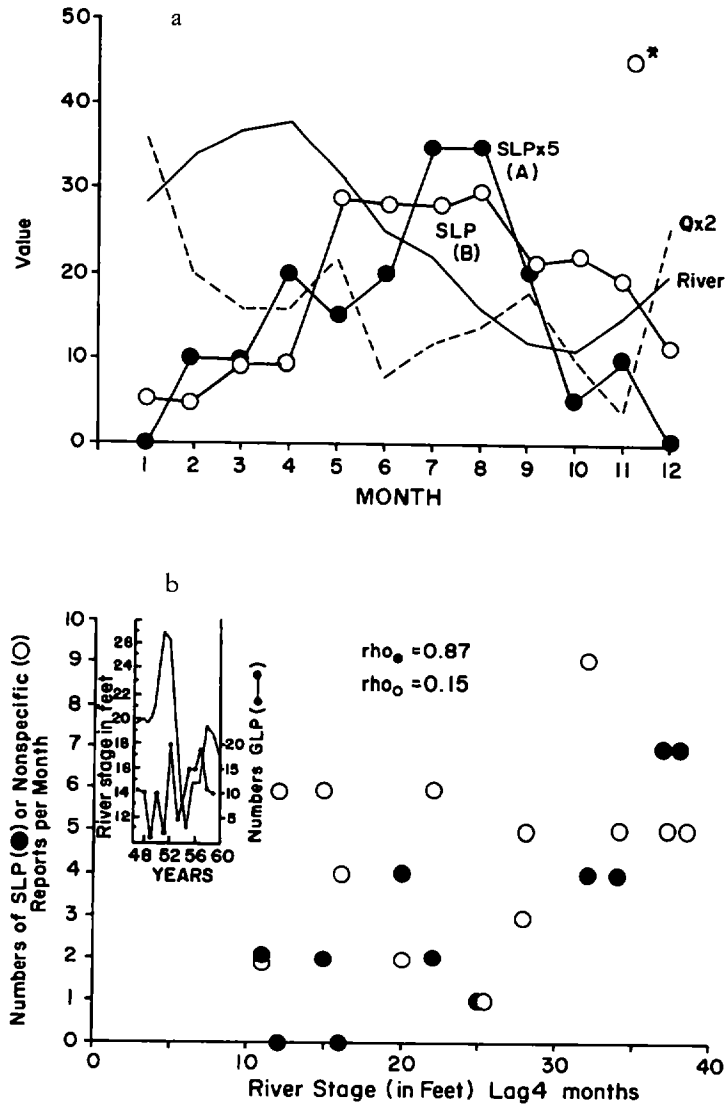

FIG. 1. (a) Values for river level (in feet), numbers of seismic events (Q x 2), specific luminous phenomena (A) within 320 km and specific luminous phenomena (B) within 600 km of the centroid of the Mississippi System as a function of month. (b) Correlations between specific luminous phenomena (●) or control cases (○) and river stage four months previously. Inset: sample segment of river stage in feet and numbers of general luminous phenomena over years.

distributions are significantly ($p < .001$) different from chance (i.e., mean = 1/12 of the total value per month) according to chi-squared analysis. The time lag between river levels and specific luminous phenomena is visually obvious; they occurred about 3 to 4 months after the river level had peaked. There was an apparent negative relationship between the numbers of luminous phenomena per month and the numbers of seismic events per month. Similar patterns were evident for the total numbers of months that contained at least one general luminous phenomenon or specific luminous phenomena as well as density of luminous phenomena.

To ascertain the quantitative relationship among these three classes of variables, seismic events, water level, and specific luminous phenomena were lagged between 1 and 12 months from each other. This was completed by simply copying the serial monthly values to obtain 24 months. However, only degrees of freedom for 12 months were employed for all analyses; Pearson *r* and Spearman *rho* values were employed; any coefficient >0.46 is significant at $p < .05$.

The results are shown in Table 1. If we assume that the river level is driving (i.e., preceded) the release of tectonic strain within the region, then the results are clear. The strongest correlation between specific luminous phenomena and river levels occurred when the latter were lagged by 3 and 4 months. The scattergram for that correlation is shown in Fig. 1b (closed circles). The correlation between river level and Type 1 or 2 CUFOS reports (primarily streaks of lights, e.g., meteors), our control cases (open circles), were not statistically significant. The relationship between specific luminous phenomena and seismic events was about 90° out of phase for a yearly cycle, i.e., 6 months.

TABLE 1

LAG PEARSON CORRELATION COEFFICIENTS BETWEEN MONTHLY SPECIFIC LUMINOUS PHENOMENA (SLP), QUAKES, AND RIVER LEVEL WITHIN 320 KM (200 MI) OF NEW MADRID, MISSOURI (1946–1964)

Lag	Q:SLP	River:SLP	SLP:Q	River:Q	SLP:River	Q:River
0	−.51	−.13	−.51	.24	−.13	.24
1	−.20	−.52	−.35	.49	.25	.12
2	−.41	−.80	.00	.64	.58	−.17
3	−.44	−.87	.28	.62	.82	−.40
4	−.00	−.69	.25	.36	.87	−.52
5	.60	−.36	.22	.06	.60	−.42
6	.57	.11	.70	−.21	.18	−.35
7	.16	.55	.60	−.42	.26	−.20
8	.32	.83	.07	−.58	−.69	.11
9	.36	.88	−.44	−.54	−.87	.36
10	.08	.69	−.41	−.37	−.86	.54
11	−.45	.35	−.42	−.09	−.58	.51
12	−.51	−.13	− 51	.24	−.13	.24

Note.—The second variable in each pair was lagged

The yearly variations in specific luminous phenomena within 200 miles of New Madrid and the monthly variations of water level near Kentucky until 1960 (the end of McGinnis's data) are shown in the inset of Fig. 1b. The database of luminous phenomena, which began in 1947, generally agrees with the pattern of river level during the extent of the data period. This would be expected if the amount of fluid was positively related to the amount of tectonic strain and was related to the numbers of luminous phenomena.

If we assume that a centroid of stress exists in the vicinity of New Madrid and that the effects of this stress focus propagate radially when integrated over time, then 200 miles (320 km) may not be the optimal distance of consideration. The distance at which the numbers of seismic events asymptote should reflect the characteristics of the cumulative stress. Using traditional models, we then determined the distance at which $1 - 1/e$ or 63% of the events had occurred: this value was 600 km. All of the general and specific luminous phenomena and seismic events within this region were determined.

The negative relationship between monthly variations in specific luminous phenomena and monthly variations in seismic events within this extended area was still strongly significant (- 0.81). There was no significant correlation (*rho* = .15) between monthly variations in specific luminous phenomena and the monthly variations in seismic events for the previous 20-yr. period (1926-1945). The correlation between monthly general luminous phenomena and seismicity was - .65. Assuming that the river systems (which would include the Ohio, Illinois, Missouri, Wabash, and Mississippi Rivers) drive the strain, one would expect a more protracted peak in specific luminous phenomena; peaks in specific luminous phenomena occurred between 1 and 4 months after the crest levels. Seismic events became more frequent 10 or 11 months later (0.56, 0.55). The monthly variations in total specific luminous phenomena per month for this extended radius are also shown in Fig. 1a [the open circle with asterisk refers to the value if the multiple reports of November 1957 were included].

If one considered the reciprocal correlation between river levels and seismic events (lagged), the model would suggest that seismic events precede the peak in water levels by 1 to 3 months; this would be compatible with McGinnis's conclusion that seismicity may be triggered by initial rates of change. If we assume that causality involves a specific temporal direction, then one would conclude that either seismic events evoked the changes in river levels (which is unlikely) or the seismic events responded to initial rates of river load. Alternatively, the maximum load of the river upon surrounding faults may attenuate their movement until the volume decreases to some critical level.

If our model is valid, then these results suggest an equilibrium system that exists between strain release as defined by seismic events, accumulation of alluvial stress (as defined by river loads), and specific luminous phenomena. There appears to be a dynamic equilibrium between specific luminous phenomena and seismic events. Because they are about 6 months out of phase, perhaps the systematic recording of the numbers of specific luminous phenomena could facilitate forecasting of subsequent earthquakes. It is relevant that one of the most optimal temporal increments in which to see the relationship between luminous phenomena and seismic activity has been 6-mo. increments and that the numbers of seismic events per 6-mo. increment are most strongly correlated with the numbers of luminous phenomena during the previous 6-mo. increment. This study also suggests that the dynamic reciprocal relationship between luminous phenomena and numbers of seismic events within this region may be "driven" as a type of chronic Zeitgeber by the (annual) monthly variations in water load within the river systems.

Commensurate with the hypothesis is the prediction that unusual annual extremes in rainfall and consequently mechanical load within large gravity-driven river basins would provide an adequate supply of water to the upper- and mid-crust (Costain, *et al.*, 1987). If the permeable crust is stressed close to failure, transient increases in hydraulic pressure would trigger a diffuse distribution of epicenters for both luminous phenomena and earthquakes. At least four historically active seismic zones that meet these criteria have been identified, Central Virginia, Giles County, Virginia, South Carolina, and Eastern Tennessee.

In this context the occurrence of the 1897 "airship" flap during which time odd, nocturnal luminosities and "airships" were seen over more than a dozen central and southern states would have been expected. At the same time luminosities were viewed by hundreds of witnesses (primarily from January through April, 1897) one of the greatest floods to have ever affected the midwestern USA. was occurring. One month later, on 31 May, the intense Giles County, Virginia earthquake struck "and the airships were seen no more."

REFERENCES

BARSTOW, N. L., BRILL, K. G., NUTTLI, O. W., & POMEROY, P. W. An approach to seismic zonation for siting nuclear power generating facilities in the Eastern United States. U.S. Nuclear Reg. Comm. NUREG/CR-1577, 1981.

COSTAIN, J. K., BOLLINGER, G. A., & SPEER, A. Hydroseismicity: a hypothesis for the role of water in the generation of intraplate seismicity. *Seismological Research Letters*, 1987, 58, 41-60.

DERR, J. S., & PERSINGER, M. A. Luminous phenomena and earthquakes in southern Washington. *Experientia*, 1986, 42, 991-999.

DERR, J. S., & PERSINGER, M. A. Geophysical variables and behavior: LIV. Zeitoun (Egypt) apparitions of the Virgin Mary as tectonic strain-induced luminosities. *Perceptual and Motor Skills*, 1989, 68, 123-128

DERR, J. S., & PERSINGER, M. A. Geophysical variables and behavior: LXIII. Quasi-experimental evidence of the tectonic strain theory of luminous phenomena: the Derby, Colorado earthquakes. *Perceptual and Motor Skills*, 1990, 71, 707-714.

MCGINNIS, L. D. Earthquakes and crustal movement as related to water load in the Mississippi Valley region. Illinois State Geological Survey (Circular 334), 1963, pp. 1-20.

PERSINGER, M. A. The tectonic strain theory as an explanation for UFO phenomena: a non-technical review of the research 1970-1990. *Journal of UFO Studies*, 1990, 2, 105-137.

PERSINGER, M. A., & DERR, J. S. Geophysical variables and behavior: XXXII. Evaluations of UFO reports in an area of infrequent seismicity: the Carman, Manitoba episode. *Perceptual and Motor Skills*, 1985, 61, 807-813.

PERSINGER, M. A., & DERR, J. S. Geophysical variables and behavior: LXXIV. Man-made fluid injections into the crust and reports of luminous phenomena (UFO reports)—is the strain field an aseismically propagating hydrological pulse? *Perceptual and Motor Skills*, 1993, 77, 1059-1065.

SHURBET, D. H. Increased seismicity in Texas. *Texas Journal of Science*, 1969, 21(1), 37-41.

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